BACTERIOLOGICAL WATER QUALITY OF STEENBURG LAKE, COUNTY OF HASTINGS

by

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Abstract

During the July and September, 1970, bacterial water quality surveys, the bacterial levels were below the water quality criteria for total body contact recreation with geometric mean levels as follows:

Survey	Total Coliform (TC)/100 ml.	Fecal Coliform (FC)/100 ml.
July 26 - 29, 1970	10	2
September 8 - 11, 1970	16	2

Some natural station-to-station variation was present but was insufficient to warrant a critical remark.

BACTERIOLOGICAL WATER QUALITY OF STEENBURG LAKE

Introduction

During the summer of 1970, two intensive bacteriological surveys were carried out on Steenburg Lake in the County of Hastings. Steenburg Lake, a roughly kidney-shaped lake with a large southern bay, is approximately two miles long by one-half mile wide. The lake has no towns or villages on its shore but the eastern shores of the lake are developed with cottages. The rest of the lake has lesser amounts of development.

The lake receives water from a number of small creeks in the southern and western portions and water flows from the lake via Steenburg Creek in the north-east.

Methods

During the two surveys, July 26 to 29, 1970 and September 8 to 11, 1970, daily bacteriological samples were taken for four days at twenty surface stations and two depth stations at stations 16 and 19. Surface stations were sampled within one meter of the water's surface with sterile polypropylene bottles obtained from the Public Health Laboratories. Depth stations were sampled using sterile 237 ml air syringes and a modified "piggy-back" sampler. After taken, samples were stored on ice until delivery to the Department of Public Health Laboratory in Peterborough. Samples were analyzed for total coliform (TC) and fecal coliform (FC) within 24 hours of sampling by the staff of the Public Health Laboratory. The analysis for total coliform and fecal coliform was carried out using the membrane filtration procedure on m-Endo broth plus agar and m-FC agar, respectively.

The data from the analyses were then evaluated on the basis of the logarithmic transformation of the individual counts and the geometric mean.

Geometric means for each station and parameter were calculated utilizing the daily counts as replicates of the station and parameter. In order to test the differences between stations for each parameter, the data was entered into a one analysis of variance or F-test computer program. This computer program also tested the normality of the transformed data and the homogeneity of the variances. If the calculated F-ratio was less than the critical F from statistical tables, no significant differences existed between the stations. The stations could be summarized as one group.

However, if the calculated F was greater than the critical F, the station or stations, which were significantly different, were determined by use of a multiple t-test which tested each station against every other station. The data from significantly different stations was withdrawn from the original grouping.

All new resultant groupings were rerun through the computer program. This procedure was repeated until all groupings showed no significant differences.

The groupings in the July survey, survey A, were then tested for significance against the groupings in the September survey, survey B, by using a t-test on the overall group means. This procedure tested the change in bacterial parameters with time.

All means were simultaneously compared with the water quality criteria for total body contact recreational use (OWRC June 1970).

Results & Discussions

Summaries of the analysis of variance groupings are presented in Tables I and III. The summaries of the tests of significance between surveys are presented in Tables II and IV.

All geometric mean bacterial levels were well below the water quality criteria for total body contact recreation (1000 TC/100 ml. and 100 FC/100 ml). Maximum geometric mean levels during both surveys were 75 TC/100 ml. and 16 FC/100 ml.

Some natural differences between bacterial levels at particular stations did occur with the TC levels at the centre of lake stations 16 and 19, especially the depth stations, being significantly lower. The TC and/or FC levels were significantly higher at station 1 during the July survey and at nearby station 20 during the September survey. These differences, although they were statistically significant, were not sufficiently significant to interpret the cause of the difference or to warrant any critical remarks concerning the water quality.

A single, unexplained, extremely high TC and FC count occurred at station 1 on July 26.

During the July survey the bacterial levels at most stations were summarized as 10 TC/100 ml. and 2 FC/100 ml. During the September survey, the TC level increased significantly to 16/100 ml. while the FC level remained unchanged at 2/100 ml. Therefore, Steenburg Lake possessed bacterial levels below the water quality criteria.

TABLE I

Summary of the Analysis of Variance Groupings of Stations
Steenburg Lake, 1970

Parameter: Total Coliform (TC)/100 ml.

Survey:		A) July 26-29, 1970	B) September 8-11, 1970
Group:		All Stations	All Stations
	F	2.63 df 21,66	2.77 df 21,66
	F(5%)	1.72	1.72
		SD	SD
Group:		1) All Stations except 1, 16D & 19D	1) All Stations except 6, 16D, 19, 19D & 2
	F	1.65 df 18,57	1.70 df 16,51
	F(5%)	1.79	1.85
		NSD	NSD
log	GM	0.9894	1.2083
	S.E.	0.0632	0.0599
	N	76.	68.
	GM	9.8	16.2
Group:		2) Station 1	2) Station 6
log	GM	1.7955	0.5242
	S.E.	0.4944	0.3346
	N	4.	4.
	GM	62.4	3.3
Group:		3) Station 16 D	3) Station 16 D
log	GM	0.0000	0.5000
	S.E.	0.0000	0.5000
	N	4.	2.
	GM	1.0	3.2

TABLE I - continued

Parameter: Total Coliform (TC)/100 ml.

Survey:	A) July 26-29, 1970	B) September 8-11, 1970
Group:	4) Station 19D	4) Stations 19 & 19D
F	-	1.24 df 1,4
F(5%)	-	7.71
	-	NSD
log GM	0.2500	0.4129
S.E.	0.2500	0.2683
N	4.	6.
GM	1.7	2.6

Group:	5) Station 20
log GM	1.8735
S.E.	0.1305
N	4
GM	74.7

TABLE II

Summary of the Tests of Significance between Surveys.

PARAMETER: TOTAL COLIFORM (TC)/ ml

Survey A

	Group	1	2	3	4
Survey B	1	2.50 SD df 144	2.17 SD df 70	-	-
	2	1.63 NSD df 78	-	-	-
	3	-	-	1.63 NSD df 4	-
	4	2.44 SD df 80	-	-	0.42 NSD df 8
	5	3.18 SD df 78	-	-	-

NSD = No Significant Difference at the 0.05 level,

SD = Significant Difference at the 0.05 level

TABLE III

Summary of the Analysis of Variance
Groupings of Stations
Steenburg Lake, 1970.

PARAMETER: Fecal Coliform (FC)/100 ml.

Survey:	A) July 26-29,1970	B) September 8-11, 1970
Group:	All stations	All stations
F	1.67 df 21, 66	2.36 df 21, 62
F(5%)	1.72	1.72
	NSD	NSD
Group:	1) All stations	1) All stations except 17 & 20
F		1.10 df 19,56
F(5%)	-	1.78
	-	NSD
log GM	0.2733	0.2084
S.E.	0.0453	0.0419
N	88.	76.
GM	1.9	1.6
Group:		2) Station 17
log GM		0.9945
S.E.		0.4451
N		4.
GM		9.9
Group:		3) Station 20
log GM		1.1944
S.E.		0.2644
N		4.
GM		15.7

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TABLE IV

Summary of the Tests of Significance
between Surveys

PARAMETER: FECAL COLIFORM (FC)/100 ml.

Survey A

	Group	1
Survey B	1	1.04 NSD df 162
	2	3.15 SD* df 90
	3	4.20 SD** df 90

NSD = No Significant Difference at the 0.05 level

SD* = Significant Difference at the .01 Level

SD** = " " " " .001 Level

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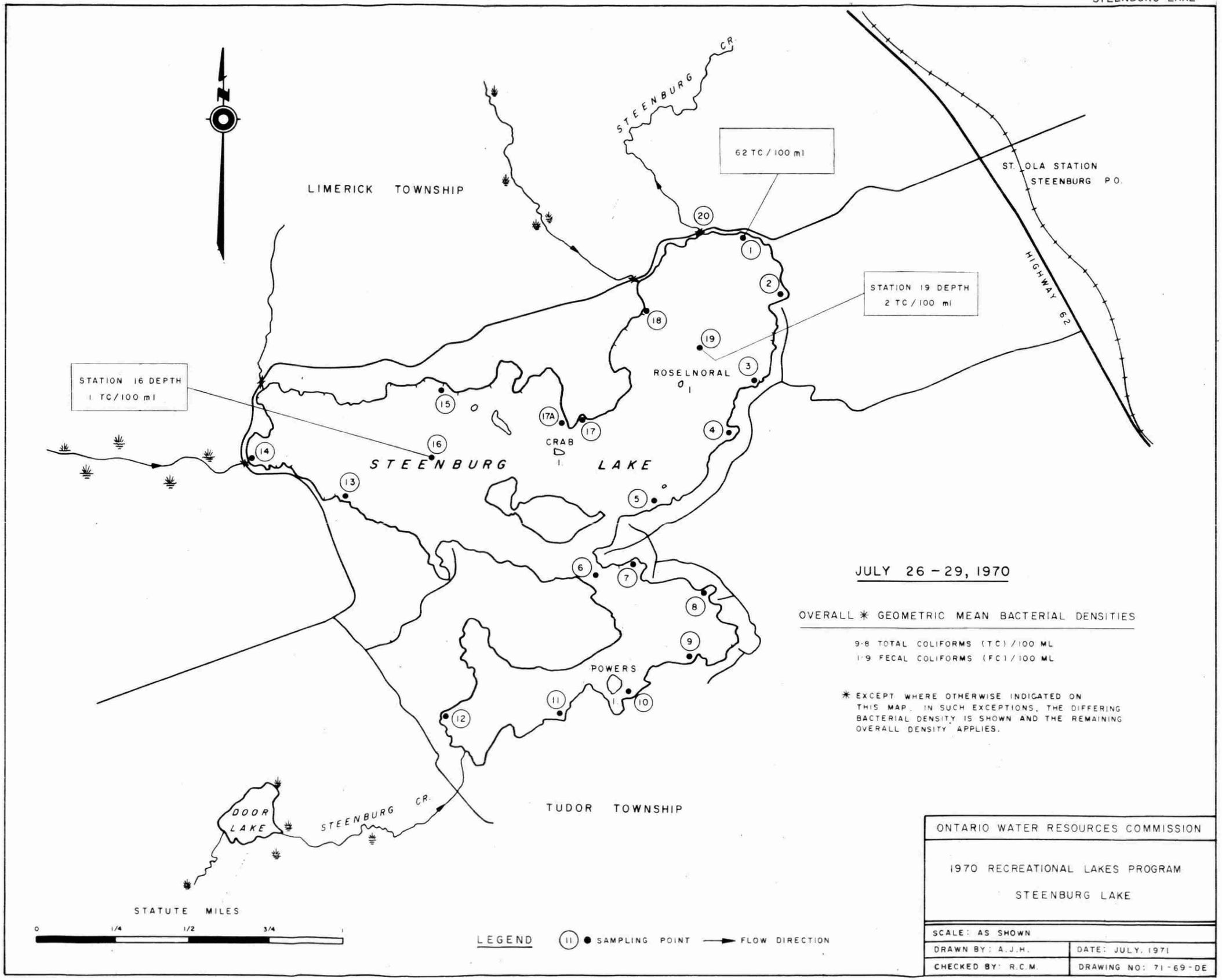
APPENDIX A - Explanation of Terms in Tables

F	the calculated analysis of various statistic or the F ratio.
df	degrees of freedom of the F ratio for "between group" and "within group" variation.
F(5%)	the critical F ratio from a statistics table.
	If the calculated F is greater than the F(5%), a significant difference (SD) occurred between the groups in the analysis. If F is less than F(5%), no significant difference (NSD) occurred.
log GM	the logarithm (base 10) of geometric mean for all groups in the analysis of variance when NSD occurred.
S.E.	the standard error of the log GM where

$$S.E. = \frac{s}{\sqrt{N}} \text{ and } s = \text{standard deviation}$$

N	the number of values in the mean.
GM	the geometric mean of the bacterial level.
t	the calculated test of significance on t - test to determine the between survey difference.
	If t for the number of degrees of freedom (df) shown is greater than the critical t value, a significant difference (SD) occurs.

STEENBURG LAKE



JULY 26 – 29, 1970

OVERALL * GEOMETRIC MEAN BACTERIAL DENSITIES

9·8 TOTAL COLIFORMS (TC) / 100 ML
1·9 FECAL COLIFORMS (FC) / 100 ML

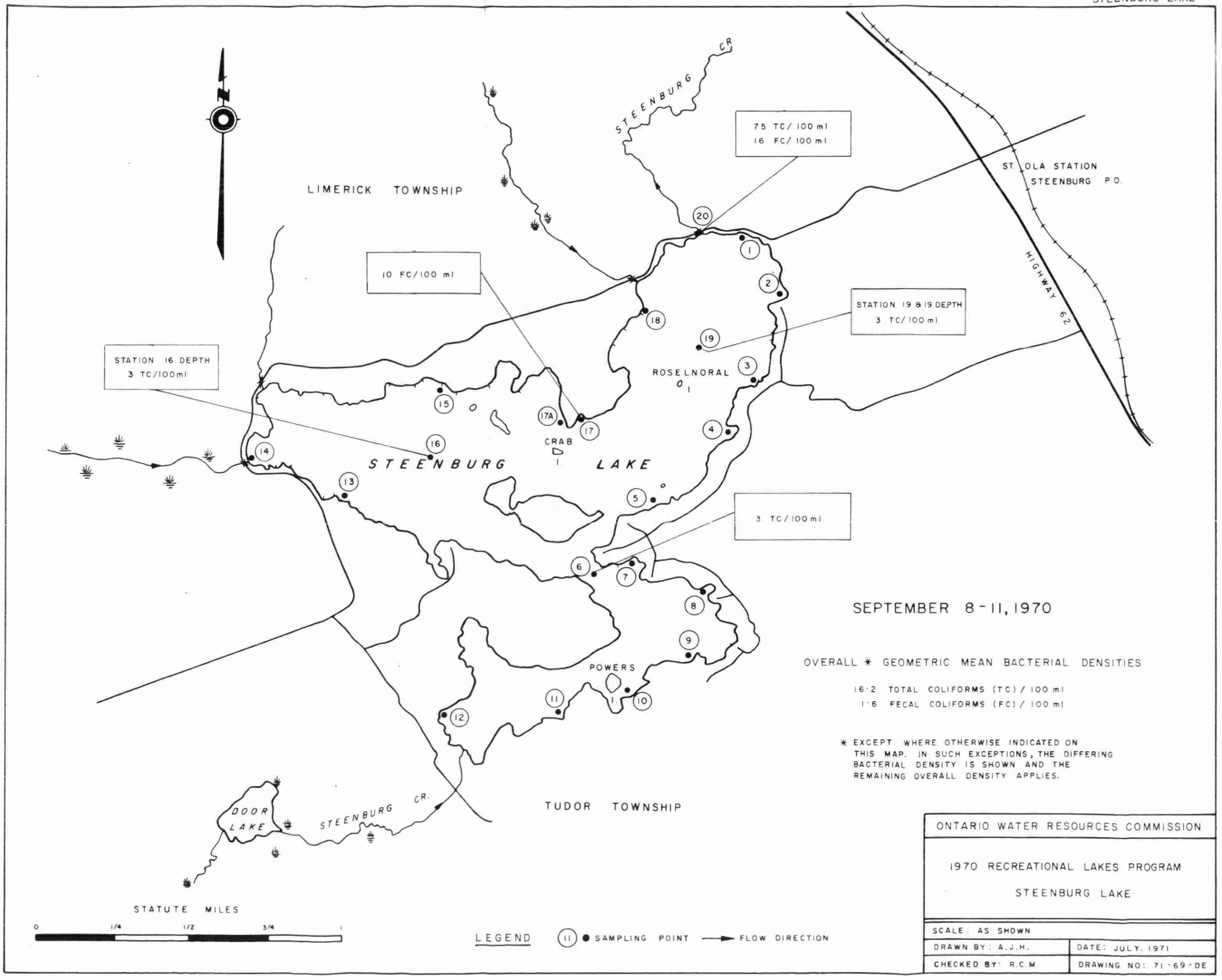
* EXCEPT WHERE OTHERWISE INDICATED ON THIS MAP. IN SUCH EXCEPTIONS, THE DIFFERING BACTERIAL DENSITY IS SHOWN AND THE REMAINING OVERALL DENSITY APPLIES.

ONTARIO WATER RESOURCES COMMISSION

1970 RECREATIONAL LAKES PROGRAM

STEENBURG LAKE

SCALE: AS SHOWN	
DRAWN BY: A.J.H.	DATE: JULY, 1971
CHECKED BY: R.C.M.	DRAWING NO: 71-69-DE



SEPTEMBER 8 - 11, 1970

OVERALL * GEOMETRIC MEAN BACTERIAL DENSITIES

16·2 TOTAL COLIFORMS (TC) / 100 ml
1·6 FECAL COLIFORMS (FC) / 100 ml

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